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FAUNA OF THE VALE AND CHOZA: 7

PELYCOSAURIA: Family CASEIDAE

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Class **REPTILIA**
Subclass **Eureptilia**
Infraclass **Synapsida**
Order **Pelycosauria**
Suborder **Edaphosauria**
Family **Caseidae**
Casea Williston

This genus has been known heretofore only from a single species, *Casea broilii* Williston (Williston, 1910). The type of the species and all referred specimens have come from a single concentration, the *Cacops* bone bed in western Baylor County, Texas. The horizon in which this bone bed was found generally has been considered to be Arroyo in age (see, for example, Romer and Price, 1940), but my recent stratigraphic studies of the complete Clear Fork section have led me to the conclusion that it actually should be placed in the lower Vale. Collections made from the Vale and Choza over the past several years include three specimens of *Casea*, two from a single nodule in the upper Vale and one from the middle Choza. The other described genera of the family Caseidae are *Cotylorhynchus* Stovall (1937) from the Hennessey Formation of Oklahoma and San Angelo Formation of Texas, and *Caseoides* and *Angelosaurus* from the San Angelo (Olson and Beerbower, 1953). As yet undescribed caseids have recently been found in the Flower Pot Formation. The only other specimen identified as a caseid—one in the collections of the University of California at Berkeley—consists of a skull from the Abo Formation of New Mexico and appears to be a very primitive member of the family, according to a personal communication from Wann Langston of the University

of California. The family had a long history and was in existence during the time of deposition of the beds of the Wichita group and the Clyde and Arroyo formations of the Clear Fork group in Texas. Intensive work by various collectors has not revealed any trace of it in the Texas area prior to the lower Vale. Presumably members of the family did not penetrate the part of the Permian delta represented by the Texas deposits until after the deposition of the Arroyo Formation.

Casea broilii Williston

This species has been rather fully described in the writings of Williston (especially 1910, 1916) and has been reviewed in detail by Romer and Price (1940). The comments that follow are brief and designed only to give a basis for comparison of *Casea broilii* with the other species to be described. *Casea broilii* was found in a concentration of vertebrates in evenly bedded red shale, in association with *Cacops aspidephorus* and *Varanops brevirostris*. It is a small, lightly built species about four feet in length and has many skeletal features in common with members of other families of the suborder Edaphosauria. The limbs are rather short in proportion to body length. Ribs are long and arched and so attached to the transverse process of the vertebrae that they produce a large, barrel-shaped body cavity. A striking feature is the flared, almost fan-shaped, dorsal part of the ilium, produced by a marked anterior extension of the bone. The pubo-ischiadic plate is broad and flattened and there is little thickening associated with the symphysial margin of the pubis and ischium. The femur is somewhat distinctive in the presence of a strong adductor process that is extended distally into a thin ridge, but this feature is developed to some extent in all edaphosaurians. The skull is edaphosaurian in its general outline and in its small size in proportion to allover body size. The pineal opening is relatively very large. Other skull features have been adequately treated by Romer and Price (1940), and, since details of the skull do not play an important part in the discussions that follow, need not be considered further at the present time.

Casea nicholsi sp. nov.[1]

Type.—C.N.H.M. U.R. 86. Part of basicranium and lower jaw, largely impression, and skeleton, including much of column except

[1] This species name is given in recognition of the aid to our studies given by Mr. Wallace Nichols of Dallas, Texas, upon whose ranch the specimens of the species were found.

tail, part of pelvis, forelimb with humerus poorly preserved, and part of hind foot.

Horizon and locality.—Upper part of Vale Formation, Clear Fork group, Early Permian, locality KC,[1] Knox County, Texas.

Referred specimen.—C.N.H.M. U.R. 85. Posterior part of skull; skeleton, including much of vertebral column except caudals, part of shoulder girdle, pelvis, femur, and head of fibula. Horizon and locality same as for type.

Diagnosis.—Pre-sacral column, with 24 vertebrae, approximately 1.25 times the length of that of *Casea broilii*. Dorso-lumbar ribs long, broadly curved, with shafts expanded from twelfth vertebra to sacrum. Phalangeal formula of front foot 2-3-3-4-3. Measurements as given in Table (pp. 195, 196).

Description and discussion.—The two specimens of this species were found together in a single nodular mass that was embedded in red shale. No other fossils were found in immediate association, but a captorhinomorph and *Dimetrodon* occur in the same bed of red shale. The two specimens of *C. nicholsi* are moderately well preserved and yield fairly complete information concerning the postcranium but relatively little about the skull. The many resemblances to *Casea broilii* leave no question about generic assignment, but the size, the character of the ribs, and the proportions of various parts of the skeleton indicate clearly that this is a different species. Since the skeleton of *Casea nicholsi* resembles that of *C. broilii* in many particulars, a full discussion of the osteology of the former is not necessary. There are, however, a number of features that are of some interest, as they complete our knowledge of the caseid skeleton or differ from comparable features in the skeleton of *Casea broilii*. These are considered briefly in the following paragraphs.

Skull (fig. 81).—Except for size, the skulls of *Casea nicholsi* and *C. broilii* are much alike in the structures that can be compared. In two specimens of *C. broilii* listed by Romer and Price (1940), the lower jaw measures 60 mm. in length, whereas the lower jaw of *C. nicholsi* measures 125 mm. The ratio between the two—1:1.81—contrasts rather sharply with the ratio of the lengths of the presacral column, which is approximately 1:1.25. Comparable measurements on the posterior parts of the skulls of *Casea broilii* and *C. nicholsi* show a rather constant relationship of about 1:1.25 respectively, suggesting that elongation was primarily in the orbital

[1] For precise location of KC, see Olson, 1948.

MEASUREMENTS

Casea broilii,[1] *nicholsi, halselli, Cotylorhynchus romeri*[1]

Measurements in millimeters

Skulls and Jaws

	Pineal		Temporal fenestrae		Lower jaw
	Posterior margin	Width	Distance between	Maximum length	Maximum length
Casea broilii (U.C. 656)..	14	11	58	20	69
C. nicholsi (U.R. 85)....	15	14	70	26	..
C. nicholsi (U.R. 86)....	..	..	..	..	125
Cotylorhynchus romeri....	24	20	114	42	135

Vertebrae

6th pre-sacral	Height of spine	Width of postzyga-pophysis	Length, anterior to postzyga-pophysis	Length, transverse process
Casea broilii (U.C. 656)..	10	12	18	9
C. nicholsi (U.R. 85)....	18	22	21	12
18th pre-sacral				
C. broilii (U.C. 656).....	12	12	24	10
C. nicholsi (U.R. 85)....	15	17	34	17
24th pre-sacral				
C. broilii (U.C. 656).....	10	17	25	2
C. nicholsi (U.R. 85)....	12	27	33	7

3rd caudal	Centrum, greatest length	Centrum, width at posterior end	Centrum, height at posterior end	Height, base of centrum to top of postzyga-pophysis
C. broilii (U.C. 656).....	18	13	12	16
C. nicholsi (U.R. 85)....	23	25	22	39

and pre-orbital regions. The validity of such ratios for purposes of interpretation is, of course, open to considerable question since it is dependent upon a number of assumptions, notably that the specimens are adults, or at least at a comparable stage of development, that they lie reasonably close to the means of their respective populations, and that the variabilities of the populations are commensurate. When, as in this case, circumstances require treatment of a very few specimens, however, such comparisons can be suggestive though they may not be definitive.

The fact that the dentitions of *Casea broilii* and *Cotylorhynchus romeri* are similar, except for numbers of teeth, suggests that the common pattern may be characteristic of the family. The only teeth preserved in the specimens of *Casea nicholsi* seem to resemble

MEASUREMENTS (*continued*)

Casea broilii,[1] *nicholsi*, *halselli*, *Cotylorhynchus romeri*[1]

Pelvis

	Ilium			Pubis		Ischium	
	Length	Width of neck	Width of base	Length	Height	Length	Height
C. broilii (U.C. 883)	57	19	41 *ca.*	..	..	..	..
C. broilii (U.C. 656)	47	18	37	44	32–	42	45–
C. nicholsi (U.R. 85)	65	29	..	77	..	62	..
C. halselli (U.R. 117)	..	45	200 *ca.*	100	..	85 *ca.*	..

Limb Bones

	Length	Proximal width	Distal width
Humerus			
C. broilii (U.C. 656)	84	30	44
C. nicholsi (U.R. 86)	100 *ca.*	..	60 *ca.*
Radius			
C. broilii (U.C. 656)	62	14	16
C. nicholsi (U.R. 86)	67	22	23
Ulna			
C. broilii (U.C. 656)	58	18	18
C. nicholsi (U.R. 86)	78	..	23
Femur			
C. broilii (U.C. 656)	85	25	29
C. nicholsi (U.R. 85)	85	39	40
C. halselli (U.R. 117)	..	63	..
Cotylorhynchus romeri	284	116	104

[1] Measurements in part from Romer and Price (1940).

those of *C. broilii*, but they are so poorly preserved that no real comparison is possible.

Vertebrae.—Pre-sacral and sacral vertebrae of the two species are very similar except for size. *Casea nicholsi* has 24 pre-sacral and three sacral vertebrae. This is the number given for *C. broilii* by Williston in his first description (Williston, 1910), but in a later paper (Williston, 1916) he mentions the pre-sacral count as 25. Transverse processes are long on all but the first few pre-sacral vertebrae. The width of the neural arches increases regularly from the cervical to the sacral region.

Ribs.—The cervical ribs are not known in *Casea broilii*. One is well shown in *C. nicholsi*. It is rather highly specialized, consisting of a very broad head and a short, tapering, somewhat recurved shaft. The first five ribs of *C. nicholsi* are short and apparently of this type. The next six are longer, strongly recurved, and little expanded.

Expansion in an antero-posterior plane becomes apparent in the twelfth pre-sacral rib and reaches a maximum at about the twentieth. It is not expressed in the sacral ribs, but two well-exposed anterior caudal ribs are broadly expanded and sharply recurved. There is no such rib expansion in *C. broilii*.

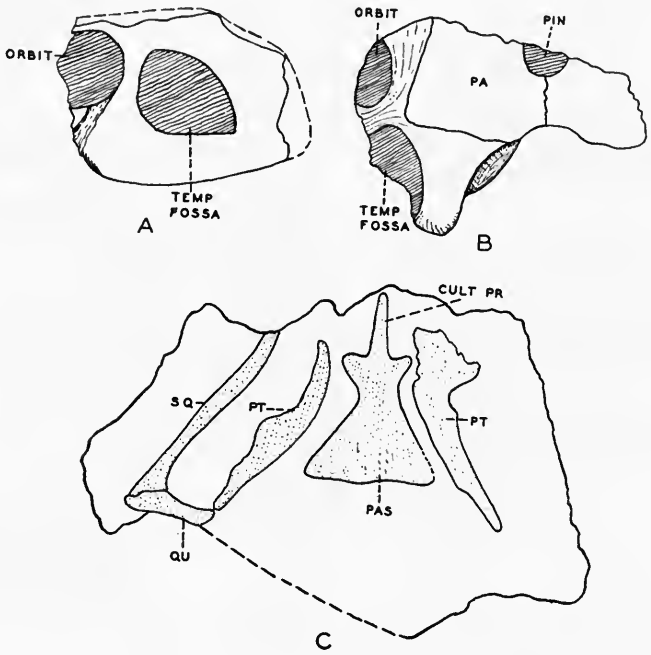

FIG. 81. Parts of skull of *Casea nicholsi*. A, lateral view of posterior part of skull, C.N.H.M. U.R. 85; B, dorsal view of posterior part of skull, C.N.H.M. U.R. 85; C, ventral view of posterior part of skull, type, C.N.H.M. U.R. 86. All × 1/2. Abbreviations: *CULT PR*, cultriform process of the parasphenoid; *PA*, parietal; *PAS*, parasphenoid; *PIN*, pineal opening; *PT*, pterygoid; *QU*, quadrate; *SQ*, squamosal; *TEMP FOSSA*, temporal fossa.

Pectoral girdle and forelimb.—The only known parts of the shoulder girdle of *Casea nicholsi* are the left scapula and a displaced clavicle in C.N.H.M. U.R. 85. These show no distinctive features and differ from comparable elements of *C. broilii* only in size. A very poorly preserved humerus, consisting of part of the head and impression of more lateral parts, is present in C.N.H.M. U.R. 86. The ratio of the length of the humerus to that of *C. broilii* is approximately proportional to the ratio of the lengths of the pre-sacral columns in the two species. The distal width is, however, somewhat

disproportionately increased to produce a relatively broader element in *C. nicholsi.* The radius and ulna show a slight to moderate increase in length, but again, as in the humerus, there is a disproportionate increase in width, particularly evident in the radius. The structure of the front foot is shown in figure 82. The most notable

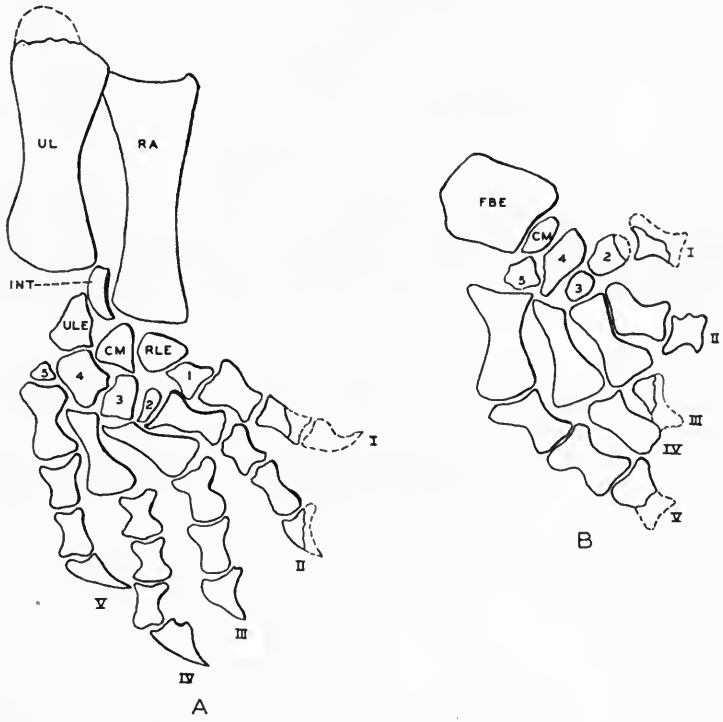

FIG. 82. Feet of *Casea nicholsi;* type, C.N.H.M. U.R. 86. A, right front foot with radius and ulna; B, part of right hind foot. Both × 1/2. Abbreviations: *CM,* medial centrale; *FBE,* fibulare; *INT,* inter-medium; *RA,* radius; *RLE,* radiale; *UL,* ulna; *ULE,* ulnare; 1–5, distal carpals and tarsals; I–V, metacarpals and metatarsals.

feature is the phalangeal formula of 2–3–3–4–3, a reduction from the typical pelycosaur formula that is exceeded only by that of *Cotylorhynchus romeri* (2–2–3–3–2).

Pelvis and hind limb (figs. 82 and 83).—The pelvis is moderately well preserved in C.N.H.M. U.R. 85 and an impression of the ilium is present in C.N.H.M. U.R. 86. The pelvis is typically caseid, as shown in figure 83. The length of the femur of *Casea nicholsi* is 1.00 to 1.25 times the length of that in *C. broilii* (based on measure-

ments of two femora from U.C. 656 for *C. broilii* and one from U.R. 85 for *C. nicholsi*). There is no conclusive evidence of proportional change with respect to the length of the column. The distal and proximal widths, however, show a ratio to length $1:145 \pm 0.05$ for *C. broilii* and *C. nicholsi* respectively, suggesting a proportional increase in these dimensions in *C. nicholsi* much like that in the forelimb. The tibia and fibula are not well enough preserved to permit comparisons. What is known of the hind foot of *Casea nicholsi* is shown in figure 82. The foot was considerably larger and more elongated than the front foot but, outside of the fact that there were at least three phalanges in the fifth toe, nothing can be determined concerning the phalangeal formula.

Casea halselli sp. nov.[1]

Type.—C.N.H.M. U.R. 117. Pelvic girdle with ilium damaged, partial left femur and tibia, head of right femur, five caudal vertebrae lacking arches, and fragments of lumbar vertebrae.

Horizon and locality.—Middle part of Choza Formation, Clear Fork group, Early Permian, Texas. Locality FC,[2] Halsell ranch, Foard County, Texas.

Diagnosis.—Length of pelvis along symphysial line about four times that of *Casea broilii*. Femora proportionately very short, about 0.75 times symphysial length of pelvis as compared to a ratio of 1.4 to 1.6 for *C. broilii*. Length of vertebral centra short with respect to symphysial length of pelvis as compared to *C. broilii*. Head of tibia proportionately very broad. Measurements as given in Table (p. 197).

Description and discussion.—The specimen was found in red shale far removed from any other known specimens. It is well above the stratigraphic level of most known Choza vertebrates, but *Dimetrodon*, *Captorhinus*, and *Xenacanthus*, among the common Choza genera, are known from still higher beds. The size and proportions of the

[1] This species is named for Mr. Glen Halsell, upon whose ranch it was found and who made possible the exploration of much of the middle and upper Choza by allowing our parties free access to the Halsell ranch in Foard County, Texas.

[2] Locality FC has not been previously mentioned in the papers on the Vale and Choza. It is located on aerial photographs as follows: CZW 2C 45, pipeline road at 6.9-7.1 south along road to 6.6-4.1, west to hill at 3.3-4.3, northeast along divide to 4.4-7.0 and along breaks to 6.9-7.1. As for all cited photo-indexes, co-ordinates are measured in inches right from the left picture margin and then up from the lower picture margin. The specific location of the type specimen of *Casea halselli* is CZW 2C 45 4.81-7.79.

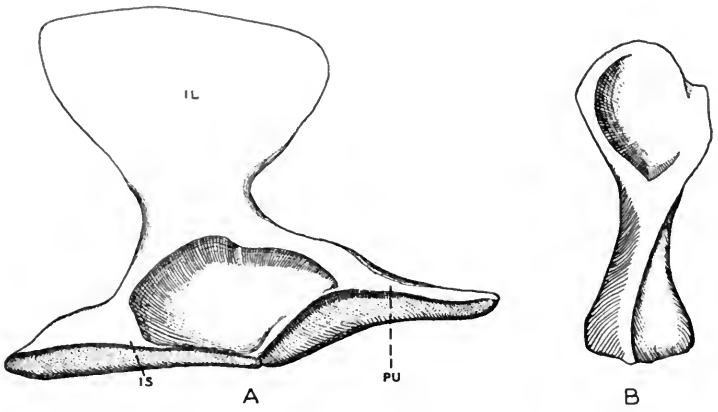

FIG. 83. A. Pelvis of *Casea nicholsi* in lateral aspect; referred specimen, C.N.H.M. U.R. 85. B. Left femur in ventral aspect; referred specimen, C.N.H.M. U.R. 85. Both $\times \frac{1}{2}$. Abbreviations: *IL*, ilium; *IS*, ischium; *PU*, pubis.

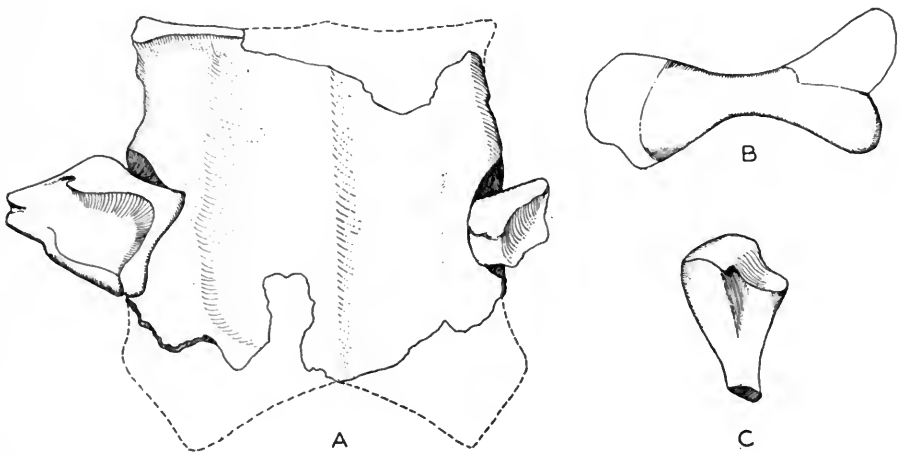

FIG. 84. *Casea halselli;* type specimen, C.N.H.M. U.R. 117. A, pelvis in ventral aspect; B, femur in dorsal aspect, reconstructed from parts of left and right femora and shown as right femur; C, right tibia in lateral aspect, distal part missing. All $\times$ 1/4.

animal, shown by the rather meager remains, leave no doubt that this find represents a species different from either *Casea broilii* or *C. nicholsi*. The affinities with *Casea* appear to be beyond question. The dimensions of the pelvis suggest an animal about the size of *Cotylorhynchus romeri*, but the vertebrae and hind limbs are very much smaller than those in specimens of *Cotylorhynchus romeri* with comparable pelvic measurements. The discrepancies are so great, in fact, that one might be led to doubt the association were it not for the fact that all known parts were found in normal position, with the limb bones in articulation with the pelvis and the caudal vertebrae appropriately disposed. The proportions are somewhat closer to those of *Casea nicholsi* than to those of *C. broilii* or *Cotylorhynchus romeri*. They seem to indicate that there was a marked proportional reduction in the length of limb bones, accompanied by a broadening, in the evolution of this species from the more primitive stock. These changes mark an accentuation of trend noted between *Casea broilii* and *C. nicholsi*.

Evolution of the Caseidae.—Although there are relatively few known caseids, it seems possible to discern certain trends of evolution that occurred during development of the known genera and species. By the time represented by lower Vale, the family had become well separated from other edaphosaurian families and the single Abo specimen shows that the separation had been accomplished well before the first appearance in the Texas record. The family must have existed elsewhere during the time interval between the deposition of the Abo and the Vale. During this period, for one reason or another, it apparently was unable to penetrate the deltaic environment and presumably carried out its development in higher lands. The rather marked environmental change at the end of the Arroyo, which temporarily altered conditions that had existed in the Arroyo and resulted in the elimination of many species, appears to have produced circumstances that permitted the immigration of *Casea*, represented by *C. broilii*. Thereupon the genus *Casea* seems to have undergone a rather rapid change, which produced forms that were larger and proportionately different from *C. broilii*, the presumed ancestor. I have not been able to visit the locality from which *C. broilii* came, since the location of the site was not sufficiently documented. It is impractical to attempt an interpretation of the environment of deposition. Both *C. nicholsi* and *C. halselli* were found in deposits that are clearly of flood plain origin and that appear to have been laid down well away from major stream channels and

bodies of standing water. All that is known of these two species suggests that they inhabited the higher parts of the delta, the divides and adjacent flood plains, and thus may have tended to preserve the habitat of the genus prior to its immigration into the deltaic region. In such an environment principal associates would have been *Dimetrodon* and *Captorhinus*. *Casea* represents the only large herbivore known from this environment during the Vale and Choza.

Evolution of the genus under the inferred circumstances was rapid relative to that of *Dimetrodon*, which shows no change during the same period. The size increase may have been related to a predator-prey relationship that presumably existed between *Dimetrodon* and *Casea*. Proportional shortening of limb bones, however, can hardly be considered adaptive with respect to predatory activity of *Dimetrodon*.

Away from the delta, a different evolutionary trend appears to have been in progress. This resulted in the development of *Cotylorhynchus*. If it may be assumed that *Casea broilii* is representative of the ancestral condition in both lines, which seems not unreasonable, then it follows that the pattern of evolution leading to *Cotylorhynchus*, while similar in the development of large-sized species, was different in that limb length was not relatively reduced but rather was somewhat increased with respect to trunk length.

Under this interpretation, considerable divergence in the two lines, one on the delta and one inland, seems to have taken place. Vertebrates recently collected from the San Angelo Formation, which overlies the Choza in Knox and Foard counties, Texas, include a very large individual of *Cotylorhynchus* and a second caseid, generically new and not as yet named, that is comparable in size to *Cotylorhynchus romeri* but possesses relatively very short and broad limb bones. These specimens seem to furnish some evidence that both lines of middle and late Clear Fork time continued successfully into the San Angelo. So far as now known, none of the genera of the delta, such as *Dimetrodon*, *Trimerorhachis*, *Diplocaulus*, or *Lysorophus*, or descendants of these genera, persisted along with the caseids into the time represented by the San Angelo.

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